PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	Group Art Unit: 2638
JELKS	Examiner: PAYNE, David C.
Serial No.: 09/663,038	**DECLARATION OF EDWARD C. JELKS (37 C.F.R. 1.132)**
Filed: September 15, 2000	
Confirmation No.: 3377	
Atty. File No.: 41992-00220	
For: "HIGH EFFICIENCY OPTICAL FEEDBACK MODULATOR AND METHOD OF OPERATION"	

CERTIFICATE OF MAILING

I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450 ON 11-10-05.

MARSH FISCHMANN & BREYFOGLE LLP

BY: Lori Lane
Lori Lane

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Edward C. Jelks, declare as follows:

1. Prior to retiring from employment by Lockheed Martin Corporation, the assignee of the above-referenced patent application, I held the position of Senior Manager, and I have more than 30 years of experience working in the field of electro-optics.

2. My education includes a Ph.D. in Electrical Engineering.

3. Based on my education and work experience I am familiar with the operation and characteristics of optical modulators.

4. An exemplary transfer curve 90 of a conventional or standard optical modulator and an exemplary transfer curve 30 of the high efficiency optical modulator invention are depicted in FIG. 5 of the above-identified patent application. The depicted transfer curves 90, 30 relate the relative optical intensity of an optical signal output by the standard and high efficiency optical modulators versus phase angle operating points and have been specified for phase angle θ. The phase angle θ is proportional to the voltage signal applied to the modulator.

5. One skilled in the art will recognize that when utilizing optical modulators to modulate an optical signal, typically an operating point is selected wherein the transfer curve is essentially linear and the slope of the transfer curve is greatest in order to achieve maximum intensity modulation efficiency with minimal signal distortion.

6. One skilled in the art will recognize that for transfer curve 90 of the standard optical modulator maximum efficiency occurs at four phase angle operating points (45, 135, 225, and 315 degrees). The slope of one such operating point (225 degrees) is depicted in FIG. 5 of the above-identified patent application by line 94b.

7. One skilled in the art will recognize that for the transfer curve 30 of the high efficiency optical modulator invention, one point of maximum efficiency occurs at a phase angle of 266.5 degrees. The slope of this operating point (266.5 degrees) is depicted in FIG. 5 of the above-identified patent application by line 94a.

8. Attached hereto as Exhibit 1 is plot showing the same transfer curves of the standard (in red) and high efficiency (in blue) optical modulators shown in FIG. 5 of the patent application with the operating points (225 degrees and 266.5 degrees, respectively) depicted.

9. One skilled in the art will recognize that the transfer characteristic of the standard optical modulator is a sinusoid and may be expressed as follows (when normalized to a maximum value of 1):

$$I_{rel} = \frac{I_o}{I_i} = \frac{1 - \cos 2\theta}{2}$$

where I_{rel} is the relative optical intensity;

I_o is the optical intensity of the output optical signal;

I_i is the optical intensity of the input optical signal; and

θ is the phase angle.

10. An analytical expression for the slope of the standard modulator transfer characteristic may be obtained by differentiating its transfer characteristic equation with respect to phase angle θ as follows:

$$\frac{d}{d\theta} I_{rel} = \frac{d}{d\theta} \frac{1 - \cos 2\theta}{2} = \sin 2\theta$$

11. The steepest slope (maximum efficiency) of the standard optical modulator therefore occurs where $\sin 2\theta$ is greatest (i.e. where it equals 1) which is at $\theta = 45, 135, 225,$ and 315 degrees. For example, at the operating point $\theta = 225$ degrees, the slope of the standard optical modulator is:

$$\sin(2 \times 225) = 1.0 \, {}^{I_{rel}}\!/_{radian}$$

or

$$1.0 \times \frac{\pi}{180} = 0.01745 \, {}^{I_{rel}}\!/_{\deg}$$

12. One skilled in the art recognizes that many standard optical modulators are specified in 2θ phase angles, and therefore their steepest slope efficiency is given by:

$$\frac{1}{2} 0.01745 = 0.008725 \, {}^{I_{rel}}\!/_{\deg}$$

13. As described on page 12, lines 18-25 of the above-identified patent application, when operated at an operating point within a specified range of phase angles (e.g., from about 250 to 300 degrees), the slope of the high efficiency optical modulator is approximately ten (10) times that of a conventionally configured standard optical modulator.

14. Based on the forgoing, for a specified range of phase angles (e.g., from about 250 to 300 degrees), the slope of the high efficiency optical modulator is at least approximately 10 times 0.008725 = 0.08725 per degree.

15. An analytical expression for the slope of the high efficiency optical modulator may be obtained by differentiating the equation of its transfer curve (Equation 2 on page 12 of the above-identified patent application) with respect to phase angle θ as follows (when normalized to a maximum value of 1):

$$\frac{d}{d\theta}\left(\frac{E_3}{E_1}\right)^2 = \frac{d}{d\theta}\left[\left(\sin\theta + \frac{g\zeta\cos^2\theta}{1+g\zeta\sin\theta}\right)^2\right]$$
$$= 2\left[\sin\theta + \frac{g\zeta\cos^2\theta}{1+g\zeta\sin\theta}\right]\left[\cos\theta + \frac{(-g\zeta\cos\theta)}{(1+g\zeta\sin\theta)^2}\left(2\sin\theta + 2g\zeta\sin^2\theta + g\zeta\cos^2\theta\right)\right]$$

16. For gains $g = 1.643$ and $\zeta = \sqrt{0.343}$ of typically available components of the high efficiency optical modulator, the slope of the high efficiency optical modulator at the operating point θ = 266.5 degrees is obtained analytically using the above differential for the high efficiency feedback modulator as:

$$11.85\,{}^{I_{rel}}\!/_{radian} \times \frac{\pi}{180} = 0.2068\,{}^{I_{rel}}\!/_{\deg}$$

or:

$$\frac{1}{2}(0.2068) = 0.1034\,{}^{I_{rel}}\!/_{\deg} \qquad (2\theta \text{ slope efficiency})$$

which is well above the minimum approximated slope efficiency of 0.08725 per degree.

17. Exhibit 2 attached hereto is an enlarged plot showing portions of transfer curves for the standard and high efficiency optical modulators, with the plot of the high efficiency optical modulator transfer curve being shifted such that its operating point is depicted as coinciding with the operating point of the standard optical modulator for comparison purposes. As can be seen in Exhibit 2, for $g = 1.643$, $\zeta = \sqrt{0.343}$, and $\theta = 266.5$ degrees, the slope of the high efficiency optical modulator is steeper than that of the standard optical modulator.

18. The slope efficiency of the high efficiency optical modulator can be significantly enhanced by utilizing a higher gain optical amplifier in the feedback loop. For gains $g = 1.658$ and $\zeta = \sqrt{0.343}$ of typically available components of the high efficiency optical modulator, the slope of the high efficiency optical modulator at the operating point $\theta = 269.0$ degrees is obtained analytically using the above differential for the high efficiency feedback modulator as:

$$37.6\,{}^{I_{rel}}\!\!\diagup_{radian} \times \frac{\pi}{180} = 0.6562\,{}^{I_{rel}}\!\!\diagup_{\deg}$$

or:

$$\frac{1}{2}(0.6562) = 0.3281\,{}^{I_{rel}}\!\!\diagup_{\deg} \qquad (2\theta \text{ slope efficiency})$$

which is also well above the minimum approximated slope efficiency of 0.08725 per degree.

19. Exhibit 3 attached hereto is an enlarged plot showing portions of transfer curves for the standard and high efficiency optical modulators, with the plot of the high efficiency optical modulator transfer curve being shifted such that its operating point is depicted as coinciding with the operating point of the standard optical modulator for comparison purposes. As can be seen in Exhibit 3, for $g = 1.658$, $\zeta = \sqrt{0.343}$, and $\theta = 269.0$ degrees, the slope of the high efficiency optical modulator is significantly steeper than that of the standard optical modulator.

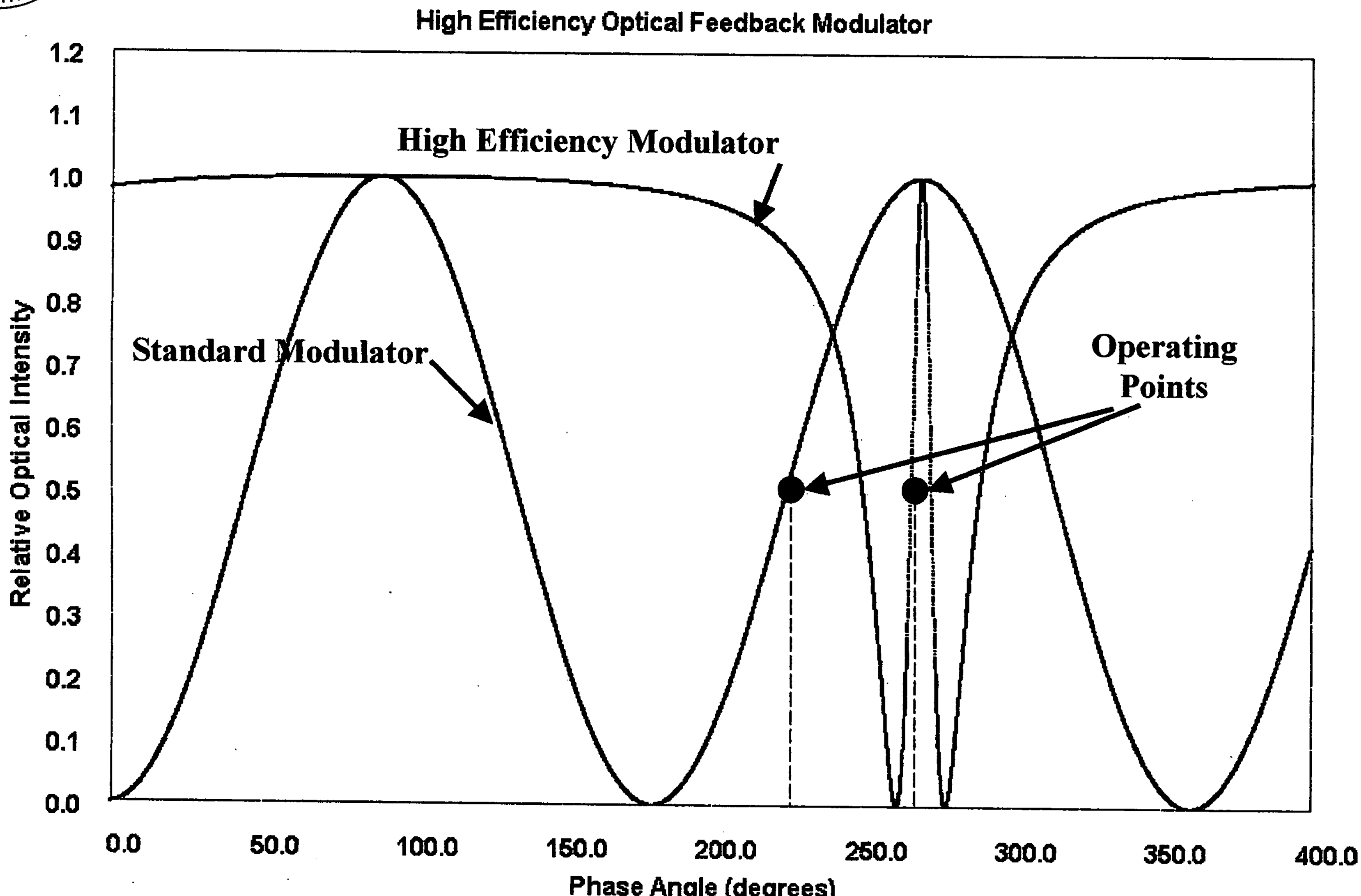
20. In the plots attached hereto as Exhibits 1, 2 and 3, gain ζ is represented by an 'e'.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true. I understand that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of this patent application or any patent issuing thereon.

Respectfully submitted,

Date: 9 Nov 2005

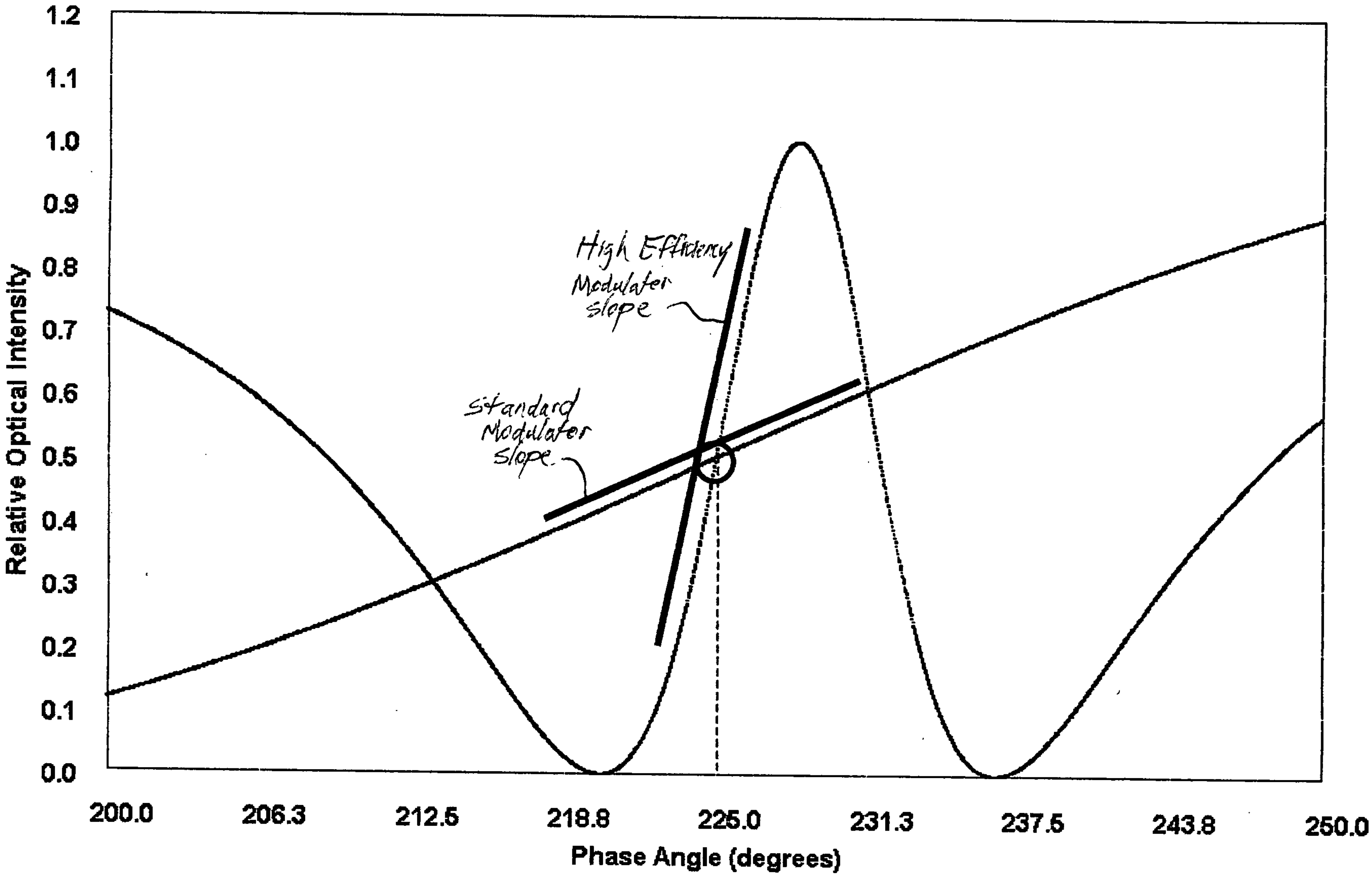
By: Edward C. Jelks
Edward C. Jelks



g = 1.643, e = sqrt(0.363)

Exhibit 1

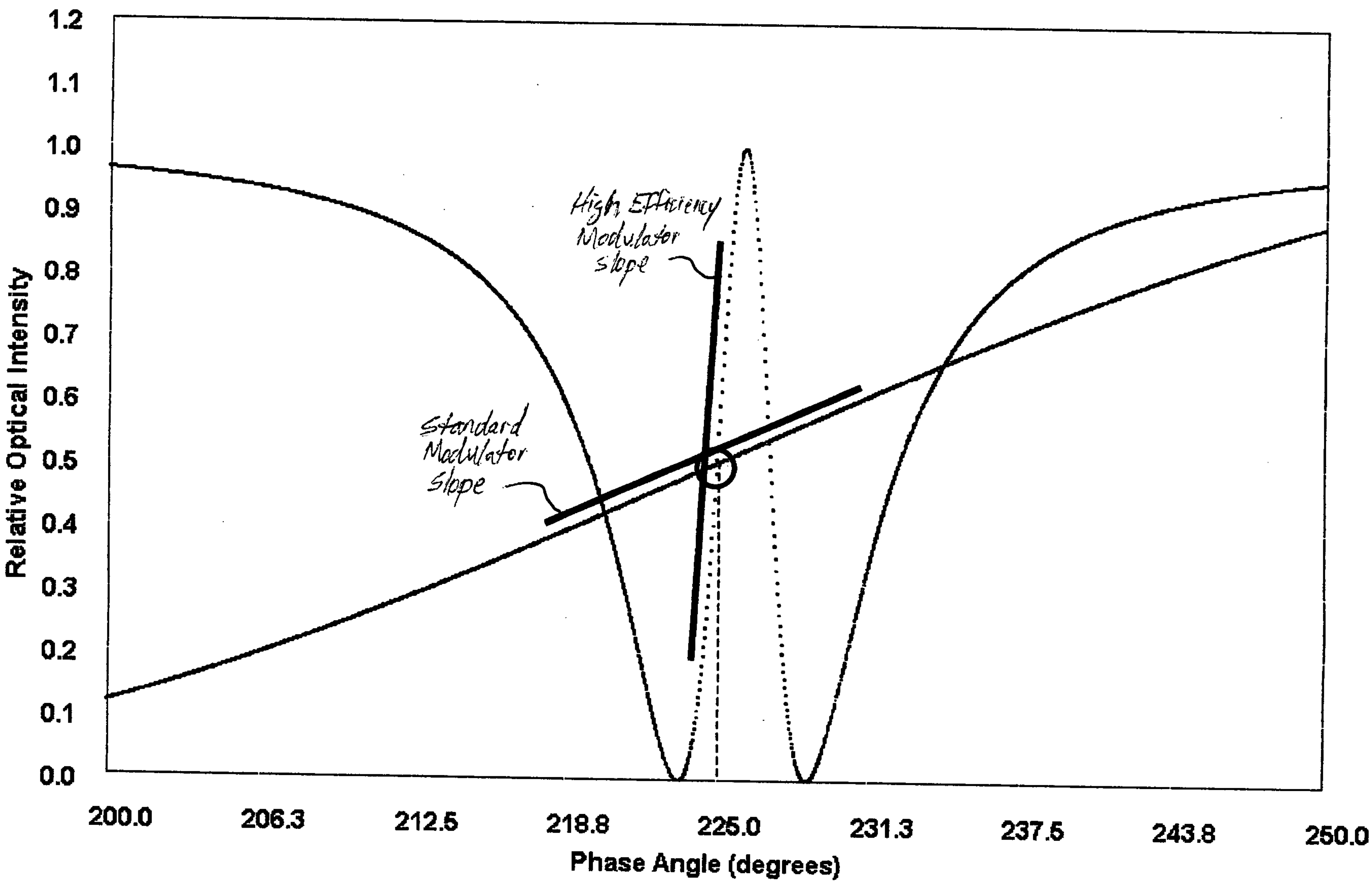
High Efficiency Modulator Shifted in Phase to Match Operating Point of Standard Modulator



g = 1.643, e = sqrt(0.363)

Exhibit 2

High Efficiency Modulator <u>with Increased Gain</u> Shifted in Phase to Match Operating Point of Standard Modulator



g = 1.658, e = sqrt(0.363)

Exhibit 3